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(54) **Optical thin film flakes, replicated optical coatings and coatings and inks incorporating the same and method.**

(57) Articles and methods for forming optically variable thin film flakes and replicated coatings having preselected optical properties. The articles are formed by coating a flexible web of material (201) with an optically variable thin film coating (202) on one surface of the web. The optically variable coating is then separated (203) from the web to form optically variable thin film flakes. The flakes are disposed in ink and paint vehicles to provide optically variable inks, paints and the like.

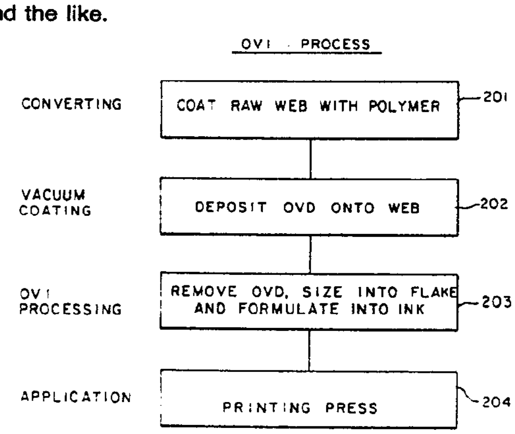

FIG.—1

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OPTICAL THIN FILM FLAKES, REPLICATED OPTICAL COATINGS AND COATINGS AND INKS INCORPORATING THE SAME AND METHOD

This invention relates to optical thin film flakes and coatings and inks incorporating the same and a method for making the same and more particularly to optically variable thin film flakes and inks incorporating the same used in anti-counterfeiting applications.

In the past attempts have been made to make lamellar pigment materials in the manner disclosed in Patent No. 4,168,986 with the desire to obtain improved specular reflectivity. In U.S. Patent No. 4,434,010 there is disclosed an article and method for forming thin film flakes and coatings. There is, however, no disclosure as to how optically variable thin film flakes for incorporation into paints and inks can be produced which incorporate the use of subtractive colorants to block out or minimize undesired colors. There is therefore a need for new and improved optically variable thin film flakes, paints and inks incorporating the same and methods for producing the same.

Figure I is a flow chart showing the optically variable ink process.

Figure 2 is a flow chart showing the optically variable ink manufacturing process.

Figure 3 is a graph showing the reflectance of a magenta-to-green shifter at I0 incidence.

Figure 4 is a graph showing the reflectance for a gold-to-green shifter at I0 incidence.

Figure 5 is a graph showing the reflectance of a gold-to-green shifter with and without a blue-light blocking pigment.

A process for making an optically variable ink (OVI) is shown in Figure I. As shown therein in a converting step 20I, the flexible web is coated with a solvent soluble polymer. The web is formed of a suitable insoluble flexible material using polyethyleneterphthalate (PET), or alternatively, using polymers such as polycarbonates and Kapton. By way of example, a I42 gauge polyester web can be utilized. The web is coated with an acrylic based polymer. One acrylic based polymer found to be satisfactory is one designated as 5I7-I and is manufactured and sold by Thermark Division of Avery International located at Schererville, Indiana. The acrylic based polymer is applied to the web in a suitable manner such as by gravure coating and dried in force air dryers. The polymer coat applied to the web is soluble in at least one solvent. Examples of suitable solvents are acetone and methethylketone. It should be appreciated that other than acrylic polymers, other materials can be utilized for a release layer. For example, instead of using a soluble hardcoat as provided by the acrylic polymer, it is possible to evaporate a thin film coating onto the web which would be soluble in certain liquids. Such a thin layer could be sodium fluoride or sodium chloride which could be dissolved with water. Also it should be appreciated that other release layers which have very low adhesion could be utilized which would permit mechanical removal of the optically variable thin film either by the use of a vacuum or by the use of air jets.

After the converting step 20I has been carried out, the flexible web can be placed in a vacuum coating chamber for performing the vacuum coating step consisting of depositing an optically variable device - (OVD) or optical thin film onto the web as shown by step 202. The optical variable device can be an optical multilayer structure of the type hereinbefore described. Alternatively, it can be of the type described in co-pending applications EP-A-0170439 and U.S. No.640,I4I, filed on July I3, I984. Optical variable devices of this character can be deposited onto the web in a conventional manner in a vacuum chamber such as by the use of electron beam and resistive heating sources as well as by sputtering.

After the multilayer coating has been deposited on the flexible web, in the vacuum coating process, the soluble polymer layer and the adhering thin film which forms the optically variable device is stripped from the carrier web. This can be accomplished batch wise or in a continuous fashion as shown by step 203 by passing the web through a bath of a suitable solvent, such as acetone. As the soluble polymer layer is dissolved by the acetone, the thin film is separated from the web mechanically. As the thin film is being removed, it breaks into optical flakes which are of a size on the order of 50 to 200 microns. If a continuous process is being used, the web as it emerges from the solvent, can be engaged by a metal doctor blade to mechanically separate any remaining thin film from the web.

The optical flakes, after they have been removed from the carrier web either in a batch process or a continuous process are then reduced in size as hereinafter described and formulated into an ink as shown by step 203. Thereafter, the ink can be utilized in various printing processes as shown by step 204.

A more detailed manufacturing process for making optically variable ink from an optical variable device manufactured in the manner hereinbefore described is shown in Figure 2. As shown therein, the soluble polymer coated web or substrate is prepared in step 206 as hereinafter described. The coated web is then supplied to a vacuum roll coater in roll form as shown in the step 207. In the vacuum roll coater, a thin film

multilayer coating can be applied over a given width using a single evaporation source with appropriate masking or can be applied to almost the full width of the vacuum roll coater using multiple evaporative sources and appropriate masking. After coating by vacuum evaporation, the web is removed from the roll coater and is slit to remove any defects or unwanted trim (edge non-uniformities).

During this editing process, the spectral properties of the thin film coating can be ascertained and supplied to a computer to provide a running color average of the coating. This makes it possible to modify the color at a later step as hereinafter described in the event that the color is slightly off the desired color for a particular roll. This makes it possible to custom blend to obtain an exact color by either adding a lower or a higher color. By having available a color profile extending along the width and length of the web, it is possible to ascertain the average color of each given roll. By way of example, if average dominant wave length of a roll is, for example, 495 microns and the desired wavelength is 490 microns, this desired wavelength can be obtained by adding some lower wavelength material having a wavelength of 485 microns to achieve the desired 490 microns.

In the next step 2Il, the thin film is stripped from the web. By way of example, this can be accomplished by taking the rolls and placing the rolls on an unwind roller and having the web pass through a solvent bath and then being taken up by a wind-up roller. The web as it passes through the solvent bath can pass through a series of rollers which are positioned below the level of the solvent bath. If any of the thin film coating still remains on the web as it emerges from the rollers in the bath, this remaining thin film can be removed by a metal doctor blade which scrapes the remaining thin film from the web. The doctor blade typically is positioned on the outside of the roll on the wind-up side so that any adhering flake will fall back into the solvent bath. As explained previously, the flakes in this operation have a tendency to drop off in sizes of approximately 50 to 200 microns.

The flakes as they fall from the web will fall to the bottom of the tank containing the solvent because they have a much higher specific gravity as, for example, approximately 3 whereas the solvent has a specific gravity of approximately l. After the settling has occurred, the clear solvent liquid above the flakes can be drained from the upper part of the tank containing the solvent. The flakes can then be removed from the tank and used as hereinafter described. Alternatively, the flakes with the remaining solvent can then be filtered and pulled dry as shown by step 2l2 by the use of a vacuum filter of a conventional type. Thereafter, fresh solvent is sprayed over the optically variable flakes forming the filter cake remaining in the filter to remove any last traces of the soluble polymer or other extraneous material from the flakes. The filter cake is then removed from the filter and broken up and then laid out to dry in an air oven at atmospheric pressure at a suitable temperature as, for example, l00 for a period of time ranging from approximately 8 to l0 hours as also shown by step 2l2.

After the flakes have been dried, they are placed in a suitable solvent solution, such as acetone or methanol and ultrasonically agitated using a conventional ultrasonic agitator as, for example, a Branson sonic dismembrator for a suitable period as, for example, approximately l hour to reduce the particle size to approximately 2-20 microns. Thereafter, the flakes are again filtered to remove the solvent and are air-dryed in an atmospheric oven at a suitable temperature, as for example, 75 overnight or until they are dry.

In order to reduce the flakes to a still smaller size, as for example, a size ranging from 2 to 5 microns, the dryed flakes are subjected to an air grind in a suitable impact pulverizer such as one manufactured by Garlock Plastomer Products, a division of Colt Industries on Friends Lane, Newton, Pennsylvania l8940. By way of example, a TX laboratory model of the air impact pulverizer has been utilized to grind alumina up to a rate of 8 pounds an hour using a l0 mesh feed to produce particle sizes down to sub micron size, as for example, 0.65 microns. It has been found by using this air impact pulverizer, 2 to 5 micron size can be readily achieved without destroying the color characteristics of the flakes. It should be appreciated that other grinding techniques can be utilized. However, care must be taken so that the grinding will not destroy the color characteristics of the flakes.

A particularly attractive feature of the air impact process for producing the small size optically variable thin film flakes is that an aspect ratio of at least 2 to l can be achieved, and a fairly narrow particle size distribution can be obtained. The aspect ratio is ascertained by taking the largest dimension of a surface of the flake parallel to the planes of the layers of the thin film and a surface (the thickness) perpendicular to the planes of the layers. In addition, the air impact process eliminates the need for additional solvent dispersal and solvent removal steps.

After the flakes have been sized, they can be blended with other flakes to achieve the exact color desired by adding flakes having a higher or lower wavelength to achieve the desired result. This sizing and blending process is represented by step 2l3 in Figure 2.

The sized and blended flakes are then introduced into an ink polymer vehicle which consists of a main vehicle with various additives in Step 2l3.

It should be appreciated that various types of ink vehicle systems can be utilized. For example, ultra-violet cured solvent systems, oxidative systems and catalytic systems can be utilized. One type of ink system which has been found to be satisfactory for use with the flakes is a catalytic system supplied by Dal Val Ink and Color, Inc. at 3101 Taylor's Lane, Riverton, New Jersey 08077 under the designations of 5-X-2575 and 5-X-2605. Another one found to be suitable is an epoxy based gravure ink supplied by Gotham Ink and Color Inc. of Long Island City, New York under Nos. 66908 and 66909.

In connection with optically variable inks, it may be desirable to add transparent dyes or pigments to the ink formulation to operate in a subtractive mode to modify the colors and/or to block unwanted colors. For example, in the case of a gold-to-green shifter, the addition of yellow dyes or yellow transparent pigments blocks the blue reflected light at large viewing angles. Blocking pigments can be added as a separate overprint ink layer or can be mixed directly into the optically variable ink, as shown by step 214. By way of example, if yellow is the color to be utilized, various transparent yellow blocking pigments are available. For example, cromophtal yellow 3G (C. I. pigment yellow 93) can be obtained from the Pigments Department of Ciba-Geigy of Ardsley, New York 10502. Sunset Gold HR Transparent 1281 (C. I. pigment yellow 83) can be obtained from Harshaw Company and Diarylide Yellow Toner AA0A-Transparent 1275 also can be obtained from Harshaw. 11-1405 Novoperm yellow HR Extra Transparent (C. I. pigment yellow 83) can be obtained from American Hoechst Corporation of Coventry, Rhode Island, as well as 11-1424 Novoperm yellow RH-02 and 11-1400 Novoperm yellow HR.

The yellow pigments are typically supplied in a yellow powder of a sub-micron size and are introduced into the ink as it is being mixed and milled to a percentage ranging from 2 to 30% by weight of the resulting optically variable ink. However, in order to achieve a brighter color it is desirable to utilize a lower percentage by weight of color, as for example, approximately 15%. The mixing and milling operation shown by step 213 is carried out to obtain good dispersion of the added pigment. It also causes good dispersion of the flakes which have been added to the paint vehicle. The mixed paint can then be packaged into desirable containers and shipped to the user as shown by step 216.

The optically variable ink produced in accordance with the present invention can be utilized with various conventional printing presses without modification of the presses. For example, the optically variable ink can be utilized in various printing processes, such as lithographic printing, letterpress printing, intaglio printing, gravure printing, screen printing, ink jet printing, and by electrostatic printing. Since the optically variable printing ink can be utilized with printing processes providing high resolution such as Intaglio, lithographic and relief printing, it can be utilized for producing security-type documents. As it is well known to those skilled in the art, the film thickness after it is applied as a wet film on full solid coated paper can have the following thicknesses:

Process	Microns (approximate)*
Sheetfed Litho	5.0
Sheetfed Letterpress	7.5
Web Offset	7.5
Web Letterpress	10
Gravure (Intaglio)	30 (variable)
Screen	25-125

*from 'What The Printers Should Know About Ink' by T. Scarlett and N. Eldred, Graphic Arts Technical Foundation, Pittsburgh, Pa. 15213, 1984, p. 2.

From the above it can be seen that the gravure or the screen ink film thicknesses are greater and thus gives greater color saturation than with the thinner ink films.

The aspect ratio is important in that it helps to ensure that the flakes will land either on their top and bottom sides and not on their ends. It can be appreciated if the flakes fall on their ends, that there would be no color shift from the flake. It is important that the optical variable device be symmetrical so that no matter which side the flake lands on, it still will give a color shift. In other words, the color will be maintained. Thus it certainly is desirable not to have a one-to-one aspect ratio but rather be at least two-to-one or three-to-one. Since the total thickness of the optically variable thin film is approximately .9 microns, the 2 micron

dimension is approximately the smallest dimension desired for the flakes. By utilizing an aspect ratio of at least 2 to I and greater, preferably 5-I0, to I, gives assurance that a major proportion of the flakes will land in the ink vehicle with an orientation such that the surfaces providing the color of the flakes will be facing upwardly since the thin film coating is symmetrical and those surfaces have the larger dimensions.

It should be appreciated that with the different wet film thicknesses it is easier to print with thicker layers of material and in addition, this makes it possible to utilize a smaller percentage of optically variable device flakes in the printing media. Thus with gravure it is possible to utilize only 25% by weight of optical variable device flakes whereas with letter press printing and other thinner coatings it is necessary to increase the percentage of optical variable device flakes to 45 to 50% by weight.

If a color shift between two colors with change of viewing angle such as a typical gold-to-green design is desired for an optically variable ink for anti-counterfeiting applications, a five layer symmetrical design of the type MDMDM where M is a metal layer and D is a dielectric layer. The materials used for M and D can be chosen from a wide variety of substances.

It has been possible to achieve very good color control with optically variable inks. To ascertain this optical variable inks were air brushed onto three different surfaces outlined below.

I. Hi-Gloss Paper

2. Bond Paper

3. Bond Paper With Water Base Base Coat

Delta E color measurements based on the CIE Lab color coordinate system were taken. Three samples were chosen to be standards against which all other samples were compared. The Delta E values are charted below:

		Standard # High Gloss 1A	Bond no Base Coat 3A	Bond with Base Coat 5A
Sample #				
High Gloss Paper	1A	--	6.18	3.39
	2A	1.62	5.36	2.56
	7B	0.58	5.86	3.04
	8B	0.31	5.93	3.15
Bond Paper No B.C.	3A	6.14	--	2.95
	4A	4.61	2.06	2.20
	9B	4.59	2.74	2.60
	10B	4.71	2.67	2.62
Bond Paper WB B.C.	5A	3.34	2.87	--
	6A	3.53	2.59	0.56
	11B	2.96	3.38	0.78
	12B	1.74	4.41	1.80

The above chart taking the --in Column IA as the standard can be seen that the change in color from the standard in terms of Delta E units is only I.62, .058 and 0.3I which shows that the difference in color from one sample to the next is minimal. For currency type paper, the color change is also very excellent ranging from 0.56 to 0.78 and I.80. The change in color is so small that for these samples it is undetectable by the human eye. It has been found that when the optical variable ink is applied to paper which does not have a base coat, then the values of delta E are slightly higher because the optically variable device flakes are not lying in a completely flat plane. By utilizing a base coat a more planar surface is provided which provides a surface that gives a higher color purity when the optically variable ink is applied to the same.

In using the yellow pigment blocker in the optically variable ink, the yellow pigment has a tendency to settle above the optically variable pigment since it has a specific gravity of approximately I with respect to the optical variable device flakes which have a specific gravity of approximately 3. In certain applications, however, the best approach in blocking out the blue reflected light at high viewing angles is to print a top coat vehicle containing the yellow pigment layer over the optically variable ink layer.

In order to achieve excellent color purity, the optically variable ink must have a good aspect ratio as, for example, at least two-to-one, preferably 5-l0 to one, as pointed out above. The optical variable device flakes should not be agglomerated but should be thoroughly dispersed throughout the ink. There should be good overlap of the flakes. The ink should have good flow characteristics. If the paper on which the printing is to occur has a rough surface, a subbing layer may be required for currency type applications where high color purity is desired. Alternatively, calendared currency paper may be very desirable to decrease surface roughness.

As also pointed out previously to obtain good optically variable ink durability, the vehicle itself must be durable and must meet press requirements. It must be able to post cure, i.e., it must be cross-linked after the print step. As also pointed out previously, air oxidization, catalyst and UV vehicles are available which cross-link after printing. The optically variable device flakes or particles which are provided as a part of the optically variable ink must be inert or alternatively, the flakes must be made oleophobic and hydrophobic or, in other words, they must be encapsulated so they will not react with chemicals such as bases or acids.

For a good quality gravure or Intaglio ink, the flakes or particle size should be in the range of 5-l5 microns. This particle size will allow the desired color purity while still allowing for fine line printing. If fine line printing is not desired, then larger size particles may be used, up to l00 microns or so. For coverage the flake or particle loading or flakes should range 30 to 50% by weight for letterpress and offset and l0 to 30% for gravure and Intaglio.

In the graph in Figure 3 there is shown the reflectance which can be obtained with a magenta-to-green shifter of the present invention. The curve 22l shows the spectrum of the foil and represents the reflectance of the coating on the polyester web. The curves 222 and 223 are of ink made from optically variable flakes made in accordance with the present invention from the foil which is represented by the curve 22l. The spectra of the ink were made from samples prepared from 20% by weight of optically variable pigment in Gotham 66908 resin catalyzed with 2.5% by weight Gotham 66909, cured at 200 for four minutes (Gotham Ink and Colors Co., Inc., Long Island City, New York lll0l). Curve 222 was obtained from ink prepared from flakes without any grinding (as removed from the web by solvent dissolving the hardcoat/release layer) whereas the other curve 223 was obtained from ink prepared from flakes that had been ground in methanol using ultrasonic dismemberment for l hour (Sonifier Cell Disruptor manufactured by Branson Sonic Power Co. set at a power setting of 9). The optical variable flakes in this grinding process were reduced to the size of approximately 5 to 20 microns. As can be seen from the curve 223, this grinding process had a very small deleterious effect on the reflectivity of the optically variable flakes. In addition, it can be seen that there is also very little degradation in the quality, including reflection, compared to the reflection received from the foil itself, before it is removed from the web.

In Figure 4, there is shown another graph giving the reflectance of a gold-to-green shifter of the present invention without the use of a blue-light blocker. As in the graph in Figure 3, the graph in Figure 4 has three curves 23l, 232, and 233 in which the curve 23l represents the reflection from the foil on the web, curve 232 represents the reflection from ink utilizing optical variable flakes obtained by removing the optically variable coating from the web by the use of a solvent but without any grinding and the curve 233 represents the reflection obtained from an ink using optical variable flakes which have been ground down to a particle size ranging from 5-20 microns. The inks were prepared in the same way as described in connection with the graph in Figure 3. Here again it can be seen that the reflectance from the inks is still very good and corresponds very closely to that of the foil itself in that there is little degradation by the grinding of the optically variable flakes to the l0-20 micron size. Note that the peak positions in wavelength for the optically variable ink correspond almost exactly to those for the optically variable coating as prepared on the vacuum roll coated web.

In Figure 5 there is shown still another graph which shows the reflectance of a gold-to-green ink shifter made in accordance with the present invention with and without the blue-light blocker. This ink was deposited onto a polyester clear film substrate. Curve 24l shows the reflectance from the PET side with an optical variable ink (OVP) utilizing optically variable flakes therein serving to provide a gold-to-green shifter without a blue-light blocker. Curve 242 shows the reflectance from the ink side of the same structure for which the reflectance is shown in curve 24l. Curve 243 shows the reflectance from the PET side having a gold-to-green shifter utilizing a blue-light blocker. Curve 244 shows the reflectance from the ink side of the gold-to-green shifter shown in curve 243 using a blue-light blocker in yellow pigment. The ink utilized for the curves shown in Figure 5 was prepared with three grams of gold-to-green optical variable flakes which had been ultransonically ground to 5-20 micron particle size. The optical variable flakes were then mixed with 7 grams of Del Val Thermoset varnish 5-X-2575 catalyzed with l0% Thermoset catalyst 5-X-2605 and cured at room temperature (Del Val Ink and Color, Inc., l30l Taylor's Lane, Riverton, New Jersey 08077). The top two curves 24l and 242 show the reflectance as a function of wavelength when the ink is prepared

and cast onto a polyester film and then viewed directly at the coating and also through the polyester film. The lower two curves are similar to those curves described above but are for inks prepared with 9.l% (by total weight) of the blue-light blocker (Cromophthal yellow pigment), optically variable flakes and the polymer vehicle. The Cromophthal yellow is manufactured by Ciba-Geigy, Glens Falls, New York. The curves 243 and 244 clearly show how the blue-light blocker in the form of the yellow pigment effectively blocks the blue light at 400 nanometers.

From the foregoing it can be seen that there has been provided an optically variable ink which can serve as a printing ink which can be applied to papers of various types including currency paper. This optically variable ink will exhibit two distinct colors, one color when it is viewed straight on or in a direction normal to the surface of the article on which the optically variable ink appears and another color when viewed at a substantial angle, as for example, 45 Thus the paper which has an optically variable ink printed thereon can be readily examined by the human eye to ascertain whether or not an optically variable ink is present by merely ascertaining the color shift by change in viewing angle. Transparent pigments and dyes can be used to block out undesired colors in the spectrum between the two desired colors. They also can be used to block out undesired high angle colors. Further, these additives can be used to modify the colors wanted at the various viewing angles. In addition, the use of the optically variable ink makes it impossible to duplicate an article with the same colors on color copiers because only one color can be copied or because the optically variable ink reproduces as black rather than as a color or because the color (at normal incidence) is not faithfully reproduced.

Therefore it can be seen that optically variable inks made in accordance with the present invention have numerous applications. They can be utilized for various decorative purposes. They also can be utilized for anti-counterfeiting purposes in currency type papers, as well as security papers.

The optically variable ink is also advantageous in that it can be utilized with existing printing processes without alteration.

Claims

l. In an optically variable ink for obtaining a color shift between two distinct colors at first and second angles of incident light, an ink vehicle and optically variable flakes disposed in the ink vehicle, each of the optically variable flakes being comprised of a multilayer thin film structure having first and second planar surfaces, and a thickness which is measured in a direction perpendicular to the layers of the thin film structure and having an aspect ratio of at least 2 to l, respectively for the first and second planar surfaces parallel to the planes of the layers of the thin film structure and surfaces perpendicular to the planes of the layers and a substantially transparent blocking pigment dispersed in the ink vehicle for blocking out undesired colors.

2. An ink as in Claim l wherein the blocking pigment blocks out undesired colors between the first and second angles of incident light.

3. An ink as in Claim l wherein the blocking pigment blocks out undesired colors at angles of incidence higher than the first and second angles of incident light.

4. An ink as in any of claims 1 to 3 wherein the flakes have a maximum dimension ranging from approximately 2 to 20 microns.

5. An ink as in any of claims 1 to 4 wherein said optical variable flakes constitute from l5 to 50% by weight of the ink.

6. An ink as in any of claims 1 to 5 wherein said multilayer thin film structure provides a gold to green color shift and wherein the blocking pigment is a yellow pigment.

7. An ink as in any of claim 1 to 6 wherein said multilayer thin film structure is symmetrical when viewed in reflection from either of the first and second surfaces.

8. In a method for producing an optically variable ink, providing a flexible web, depositing a release coat upon the flexible web, depositing an optically variable multilayer coating on the release coat, passing the web containing the release coat and the optically variable multilayer coating thereon into a solvent to dissolve the release coat, removing the optically variable multilayer coating from the web and causing the same to break into flakes, drying the flakes, sizing the flakes, introducing the flakes into a liquid vehicle so that they are disbursed therein and adding a blocking pigment to the liquid vehicle so that the blocking vehicle in conjunction with the optically variable multilayer coating produces two distinct colors at two different angles of incident light and substantially no color at another angle of incident light.

9. A method as in Claim 8 wherein the variable flakes are sized by the use of an air polarizer.

I0. In an article adapted to be utilized in the production of an optically variable device, a flexible web, a release layer formed on the web, an optically variable multilayer coating disposed on the release coat, said coating having first and second surfaces with the second surface facing the release coat, and subtractive colorant means disposed on the first surface of the coating and serving to provide in combination with the multilayer coating two distinct colors at two different angles of incident light and substantially no color at another angle of incident light.

II. An article as in Claim I0 wherein said another angle of incident light is between first and second angles of incident light.

I2. An article as in Claim I0 wherein said another angle is at a higher angle than the first and second angles of incident light.

I3. An article as in any of claims 10 to 12 wherein said multilayer coating is symmetrical when viewed in reflection from either of said first and second surfaces.

I4. In a method for forming an optically variable device by the use of a flexible web of material, depositing a release coat upon the flexible web of material, forming a multilayer thin film optical coating on said release layer, forming subtractive colorant means on the surface of said multilayer coating, separating said flexible web of material from said release coat and securing said multilayer thin film coating with said subtractive colorant means thereon to another surface so that the multilayer interference coating can be viewed by reflection through the subtractive colorant means.

I5. A method as in Claim I4 wherein said multilayer thin film coating is formed in an inverted manner on said web.

I6. A method as in Claim I4 wherein said multilayer thin film coating is formed symmetrically on said web and wherein said subtractive colorant means is provided on both sides of said symmetrical multilayer thin film coating.

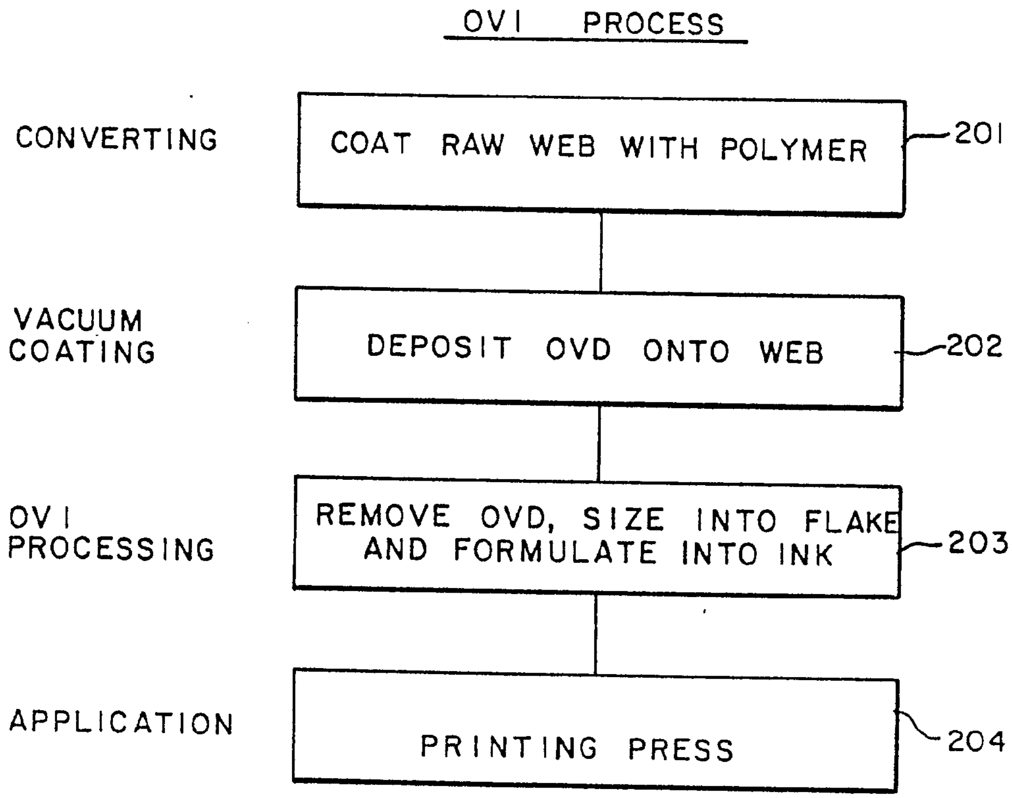
OVI PROCESS
CONVERTING
COAT RAW WEB WITH POLYMER
201
VACUUM COATING
DEPOSIT OVD ONTO WEB
202
OVI PROCESSING
REMOVE OVD, SIZE INTO FLAKE AND FORMULATE INTO INK
203
APPLICATION
PRINTING PRESS
204

FIG.—1

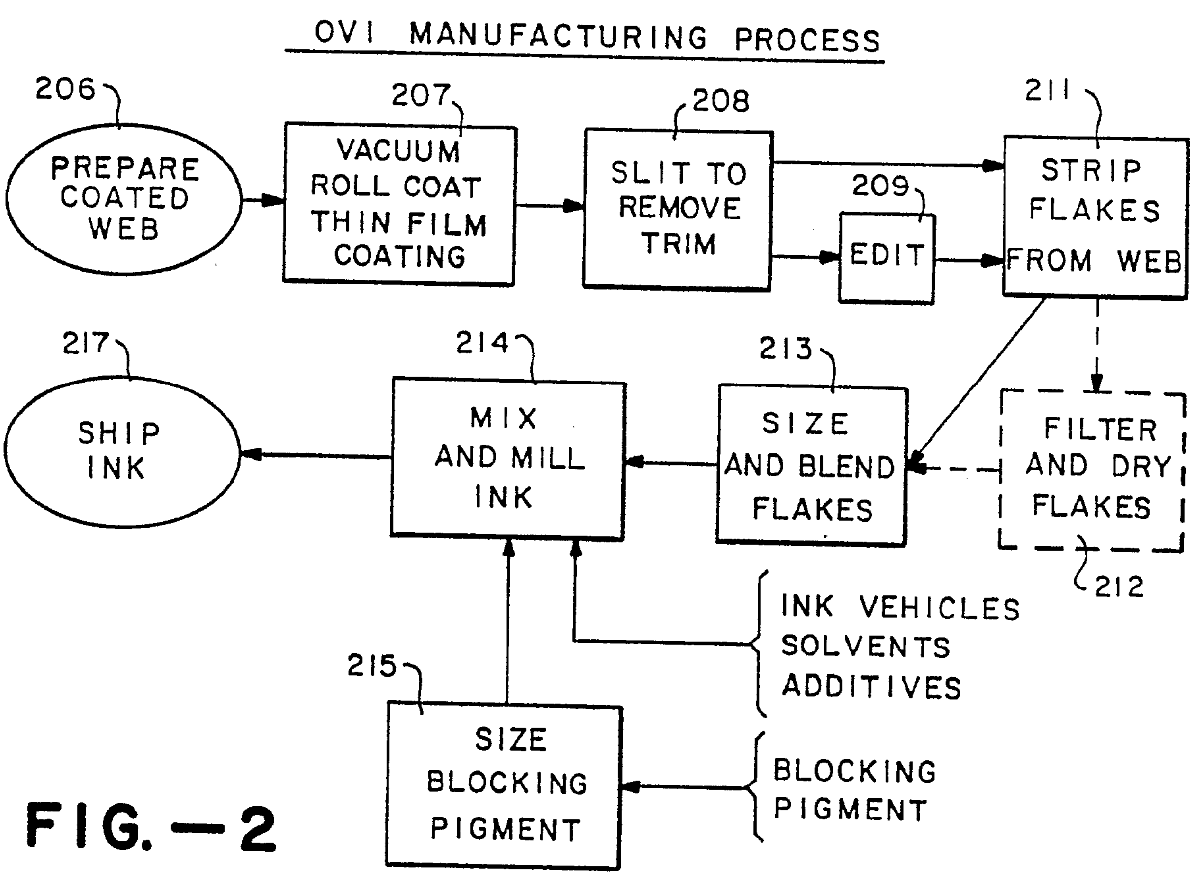
OVI MANUFACTURING PROCESS
206
PREPARE COATED WEB
207
VACUUM ROLL COAT THIN FILM COATING
208
SLIT TO REMOVE TRIM
209
EDIT
211
STRIP FLAKES FROM WEB
212
FILTER AND DRY FLAKES
213
SIZE AND BLEND FLAKES
214
MIX AND MILL INK
217
SHIP INK
INK VEHICLES
SOLVENTS
ADDITIVES
215
SIZE BLOCKING PIGMENT
BLOCKING PIGMENT

FIG.—2

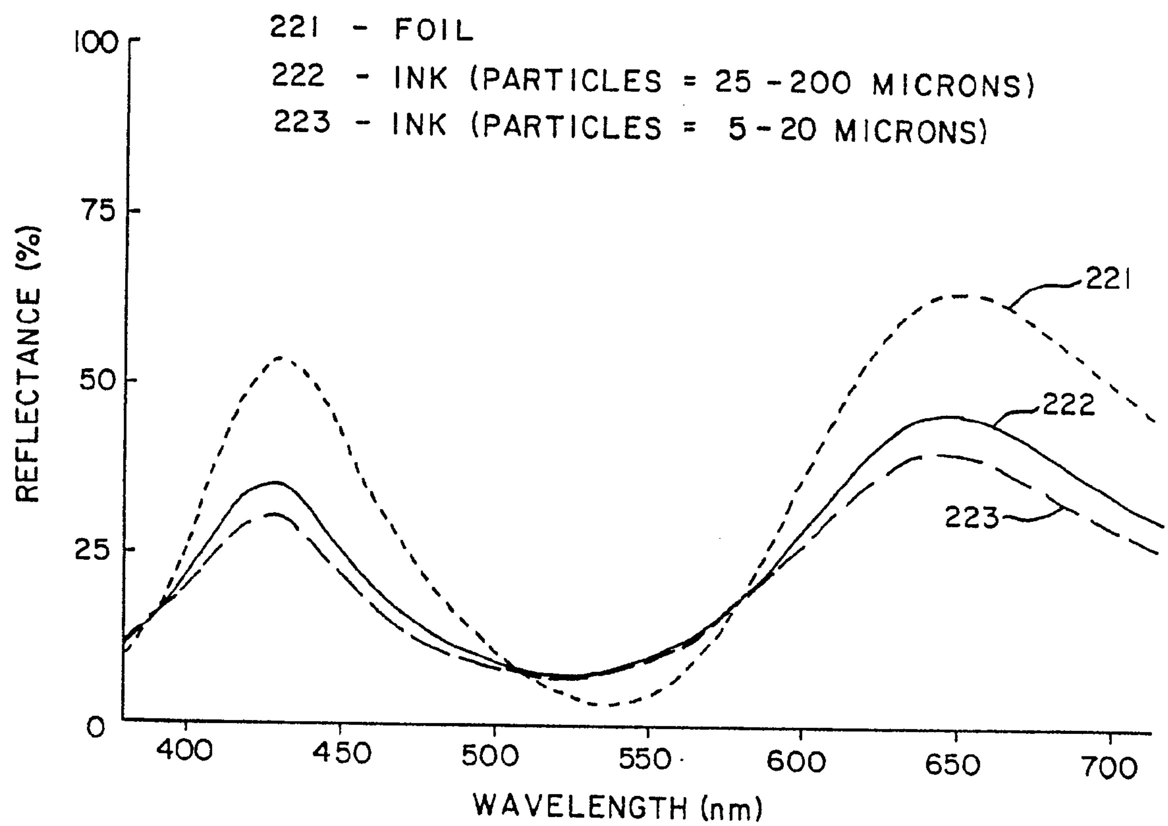
221 - FOIL
222 - INK (PARTICLES = 25 - 200 MICRONS)
223 - INK (PARTICLES = 5 - 20 MICRONS)
REFLECTANCE (%)
100
75
50
25
0
400
450
500
550
600
650
700
WAVELENGTH (nm)
221
222
223

FIG. — 3

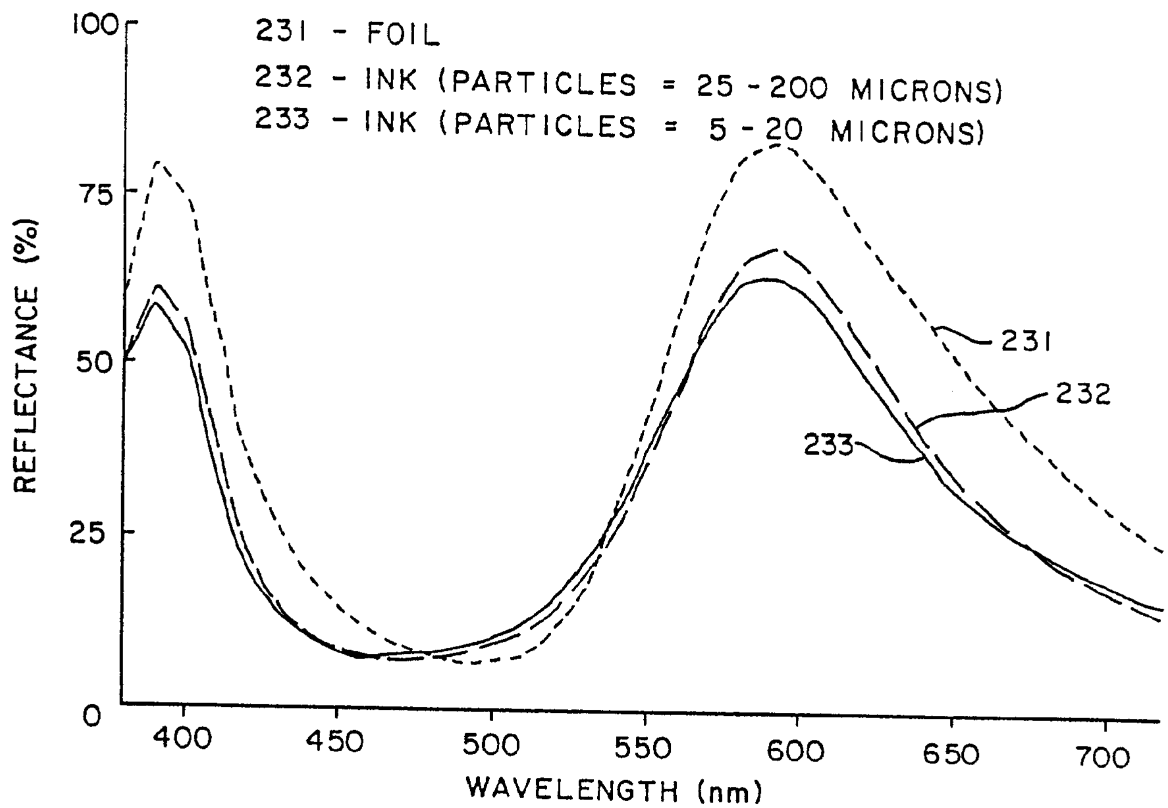
231 - FOIL
232 - INK (PARTICLES = 25 - 200 MICRONS)
233 - INK (PARTICLES = 5 - 20 MICRONS)
REFLECTANCE (%)
100
75
50
25
0
400
450
500
550
600
650
700
WAVELENGTH (nm)
231
232
233

FIG. — 4

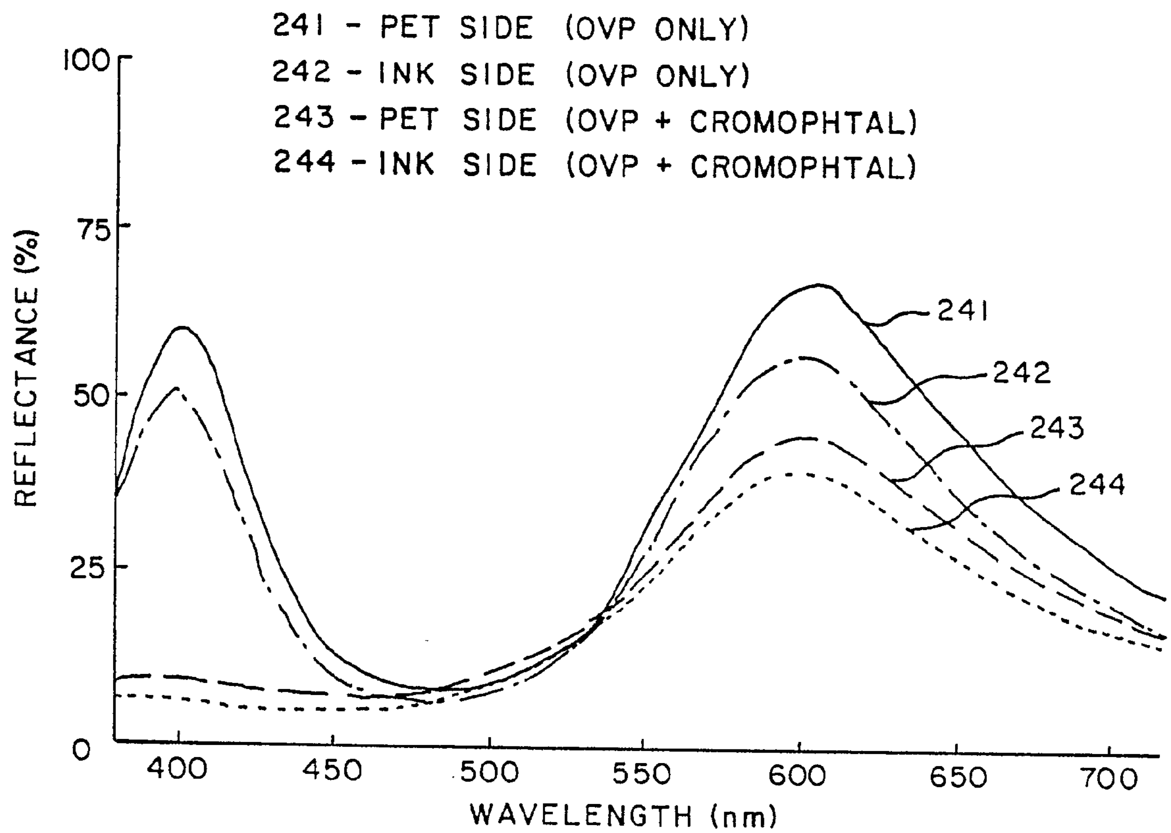
241 - PET SIDE (OVP ONLY)
242 - INK SIDE (OVP ONLY)
243 - PET SIDE (OVP + CROMOPHTAL)
244 - INK SIDE (OVP + CROMOPHTAL)
REFLECTANCE (%)
100
75
50
25
0
400
450
500
550
600
650
700
WAVELENGTH (nm)
241
242
243
244

FIG. — 5